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(54) **Catalytic converter and diesel particulate filter.**

(57) A catalytic converter or diesel particulate filter or trap (10) has an edge protectant (34) which reduces erosion of a lateral edge (33) of an intumescent mounting mat (32) when exposed to hot, impinging gases. The edge protectant material comprises binder material in the range from about 5 to about 85 percent by weight and dispersed therein glass particles in the range from about 95 to about 15 percent by weight, based on the total weight of said binder material and said glass particles, wherein said glass particles are made of a glass having a softening point of at least about 350 °C, and wherein the combined weight of said binder material and said glass particles is at least 20 percent by weight of the total weight of said edge protectant material.

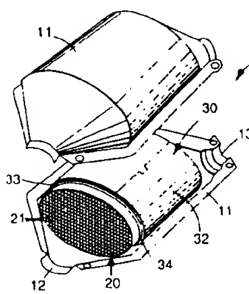

Fig. 1

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(d) the edge protectant material disposed between the metallic casing and the catalytic converter element or the diesel particulate filter element and positioned with respect to the lateral edge of the mounting mat such that erosion of at least a portion of the lateral edge is reduced when exposed to hot, impinging gases.

In yet another aspect, the present invention provides a catalytic converter or a diesel particulate filter comprising:

(a) a metallic casing;

(b) a catalytic converter element or a diesel particulate filter element disposed within the metallic casing; and

(c) the heated product of:

(i) an intumescent mounting mat having a lateral edge disposed between the catalytic converter element or the diesel particulate filter element and the metallic casing for positioning the catalytic converter element (or diesel particulate filter element) within the metallic casing and for absorbing mechanical vibration; and

(ii) the edge protectant material disposed between the metallic casing and the catalytic converter element or the diesel particulate filter element, and positioned with respect to the lateral edge of the mounting mat such that erosion of at least a portion of the lateral edge is reduced when exposed to hot, impinging gases.

In this application:

"binder material" refers to polymeric and other organic components of the edge protectant material that impart flexibility and hold the glass particles together;

"resilient" refers to the ability of a sheet or mat to conform to a curved surface (i.e., to wrap around a curved surface) without undesirable buckling or cracking of the sheet or mat;

"to reduce erosion of the lateral edge when exposed to hot, impinging gases" refers to the reduction in erosion of the lateral edge of the mounting mat by hot, impinging gases due to the presence of the edge protectant material;

"conformable" refers to the ability of the edge protectant material to accommodate dimensional changes during heating to, cooling from, and at use temperatures;

"glass frit" refers to glass (e.g., silicate glass) that has been melted and quenched (e.g., in water or air) to form small, friable glass particles;

"glass" as used herein refers to an amorphous (i.e., a material having a diffuse x-ray diffraction pattern without definite lines to indicate the presence of a crystalline phase) inorganic oxide material;

"softening point" refers to the temperature at which a glass in the form of a fiber of uniform diameter elongates at a specific rate under its own weight; and

"heated product" refers to a mounting mat according to the present invention wherein at least about 50% (preferably, at least about 75%, most preferably, at least about 100%) by weight of the heat fugitive material (e.g., organic material and water, and/or solvent) present in the mounting mat has been removed by heating.

The use of the edge protectant material provides a solution to the problem of erosion of the lateral edge of an intumescent mounting mat when in use in an environment with an impinging gases above about 350 °C.

Brief Description of the Drawing

FIG. 1 is a perspective view of a catalytic converter (or diesel particulate filter) according to the present invention shown in disassembled relation;

FIG. 2 is a partial cut away view of a catalytic converter (or diesel particulate filter) according to the present invention;

FIGS. 3, 4, and 5 are each partial views of mounting mats according to the present invention;

FIG. 6 shows an embodiment of a mounting mat;

FIG. 7 is a perspective view of a catalytic converter (or diesel particulate filter) according to the present invention shown in disassembled relation; and

FIG. 8 is a partial cutaway view of a catalytic converter (or diesel particulate filter) according to the present invention.

wall of one cell and exits the structure through another cell. The size of the diesel particulate filter element depends on the particular application needs. Useful diesel particulate filter elements are commercially available, for example, from Corning Inc. of Corning, NY, and NGK Insulator Ltd. of Nagoya, Japan. Further, useful diesel particulate filter elements are discussed in "Cellular Ceramic Diesel Particulate Filter," Howitt et al., Paper No. 810114, SAE Technical Paper Series, 1981.

Suitable intumescent sheet material, which is typically resilient, is known in the art. Factors to consider in choosing an intumescent sheet material include the use temperature and the type of monolith (e.g., ceramic monolith or metallic monolith). Suitable intumescent sheet materials typically comprise unexpanded vermiculite ore (commercially available, for example, from W. R. Grace and Co. of Cambridge, MA), organic binder and/or inorganic binder, ceramic fibers, and filler (e.g., clay (e.g., kaolin) and hollow ceramic beads or bubbles). For example, U.S. Pat. No. 3,916,057 (Hatch et al.) discloses intumescent sheet material comprising unexpanded vermiculite, inorganic fibrous material, and inorganic binder. U.S. Pat. No. 4,305,992 (Langer et al.) discloses intumescent sheet material comprising ammonium ion- treated vermiculite, inorganic fibrous material, and organic binder. Further, intumescent sheet material is commercially available, for example, from the 3M Company of St. Paul, MN, under the trade designation "INTERAM MAT MOUNT."

Suitable organic binders for the intumescent sheet material are known in the art and include polymers and elastomers in the latex form (e.g., natural rubber latices, styrene-butadiene latices, butadieneacrylonitrile latices, and latices of acrylate and methacrylate polymers and copolymers). Suitable inorganic binders are known in the art for such use and include tetrasilisic fluorine mica, in either the waterswelling unexchanged form or after flocculation as the exchanged salt with a divalent or polyvalent cation, and bentonite.

The mounting mat can be cut to any desired size and shape. The size and shape of the high temperature mounting mat according to the present invention depends on the application requirements. For example, automobile catalytic converters typically are smaller than diesel converters and generally require a correspondingly smaller mounting mat. Mounting mats can be stacked so that more than one layer of mat is wrapped around a monolith. Typically, the thickness of each intumescent sheet is in the range from about 1.5 mm to about 10 mm.

In another aspect, the weight per unit area value of each intumescent sheet typically ranges from about 1000 g/m^2 to about 7000 g/m^2.

The edge protectant material preferably comprises binder material in the range from about 15 to about 85 (more preferably, about 25 to about 75, and most preferably, about 35 to about 45) percent by weight and dispersed therein glass particles in the range from about 85 to about 15 (more preferably, about 75 to about 25, and most preferably, about 60 to about 30) percent by weight, based on the total weight of the edge protectant material.

Suitable organic binder materials for the edge protectant material include aqueous polymer emulsions and solvent-based polymers, and 100% solids polymers. The solvent-based polymeric binders can include a polymer such as an acrylic, a polyurethane, or rubber-based organic polymer which allow flexibility. The 100% solids polymers include natural rubber, styrene-butadiene rubber, and other elastomers.

The binder material can include at least one of a tackifier(s), a plasticizer(s), or both. Tackifiers, or tackifying resins can be hydrocarbons or modified resin esters, and typically provide adhesive-type properties to a polymer. Tackifiers aid in holding the binder, glass, particles and filler together. Plasticizers tend to soften a polymer matrix and thereby contribute to the flexibility and moldability of the edge protectant material. It is desirable that the edge protectant material be flexible and moldable so that it can conform, for example, to the shape of the gap between, for example, a catalytic converter element and a metallic casing.

Preferably, the organic binder material includes an aqueous acrylic emulsion. Acrylic emulsions are preferred because of their aging properties and noncorrosive combustion products. Useful acrylic emulsions include those commercially available under the trade designations "RHOPLEX TR-934" (a 44.5% by weight solids aqueous acrylic emulsion) and "RHOPLEX HA-8" (a 44.5% by weight solids aqueous emulsion of acrylic copolymers) from Rohm and Haas of Philadelphia, PA. A preferred acrylic emulsion is commercially available under the trade designation "NEOCRYL XA-2022" (a 60.5% solids aqueous dispersion of acrylic resin) from ICI Resins US of Wilmington, MA.

A preferred organic binder material comprises acrylic resin in the range from about 20 to about 40 percent by weight, plasticizer(s) (e.g., such as that commercially available under the trade designation "SANTICIZER 148" (isodecyl diphenyl diphosphate) from Monsanto of St. Louis, MO) in the range from about 40 to about 20 percent by weight, tackifier(s) (e.g., rosin tackifier such as that commercially available under the trade designation "SNOWTACK 820A" (a 50% by weight aqueous rosin dispersion; melting point

the trade designations "NEXTEL 312 CERAMIC FIBERS," "NEXTEL 440 CERAMIC FIBERS," and "NEXTEL 550 CERAMIC FIBERS" from the 3M Company, "FIBERFRAX 7000M" from Carborundum Company of Niagara Falls, NY, "CERAFIBER" from Thermal Ceramics of Augusta, GA, and stainless steel fibers (commercially available, for example, under the trade designation "BEKI-SHIELD GR90/C2/2" from Bekaert Steel Wire Corp. of Atlanta, GA). Suitable ceramic fibers are also disclosed in U.S. Pat. Nos. 3,795,524 (Sowman) and 4,047,965 (Karst et al.).

The edge protectant material can be secured to the sheet material, for example, by means of a pressure sensitive adhesive tape or film or a metallic fabric (e.g., a stainless steel screen). A preferred metallic fabric is made of woven metal (preferably stainless steel) wire with an open area of less than 90%, wherein the wire has a diameter less than 1 mm (preferably about 0.20 mm). If additional means for securing the metal fabric are needed, such means can include tape, adhesive, and mechanical means such as sewing, stapling, nailing, riveting, staking, or crimping. Preferably, the edge of the metal fabric extends up to about 8 mm beyond the lengthwise edge of the mounting mat. Although typically preferred, it is not necessary that the entire length of the mat be covered by the metal fabric.

Alternatively, in some embodiments, the edge protectant material may be placed at the edge of the mat without reinforcement or fastening.

The edge protectant material may also be useful in the construction of insulated end-cones of catalytic converters and insulated double-walled exhaust pipes.

Objects and advantages of this invention are further illustrated by the following examples, but the particular materials and amounts thereof recited in these examples, as well as other conditions and details, should not be construed to unduly limit this invention. All parts and percentages are by weight unless stated otherwise.

Examples 1-44

The formulations of Examples 1-44, which are useful as the edge protectant material are given in Table 1, below.

Example No.	Binder, %	Clay, %	Ceramic fiber, %	Glass particles, %	Boric acid, %	Hydrated sodium silicate, %	Sodium silicate cement, %	Expanded vermiculite, %	Zinc borate, %	Delaminated vermiculite, %	Ball milled ceramic fiber, %
14	35		0.7	57			5.1	1.1	1.1		
15	35		1.4	57			2.2	2.2	2.2		
16	35		2.5	57				5.5			
17	35			57			8				
18	35		1.2	57			3.4		3.4		
19	35		1.9	57			1.1	1.1	3.9		
20	35		1.2	57			3.4	3.4			
21	35		2.5	57			5.5				
22	35		1.2	57				3.4	3.4		
23	35		2.5	57					5.5		
24	35			57				8			
25	35			57					8		
26	35			55	0.5		2	7.5			
27	35			60	0.5		2	2			

Example No.	Binder, %	Clay, %	Ceramic fiber, %	Glass particles, %	Boric acid, %	Hydrated sodium silicate, %	Sodium silicate cement, %	Expanded vermiculite, %	Zinc borate, %	Delaminated vermiculite, %	Ball milled ceramic fiber, %
42	38			5				5		14	38
43	38	27	2	13				6			14
44	35	9	7	49							

In Example 1, a 500 gram sample was prepared by charging a mogul mixer (#59821 from Baker Perkins of Saginaw, MI) having a 1 liter capacity, first with dry powder ingredients (i.e., clay) and then blending them for about 1-3 minutes. Next, the liquid ingredients (i.e., binder mixture) were added to the blend and the resulting material mixed for about 15-30 minutes. The fiber material was then added to the mixer and blended in for about 10-20 minutes.

Examples 26-28

The discs of material, heated to about 900 °C, were firm. The heated discs were fused, without the appearance of having melted, and did not exhibit cracking or spalling.

Example 29

The disc of material, heated to about 900 °C for about 17.5 hours, melted due, it was thought, to the presence of the boric acid (a fluxing agent).

Examples 30-35

The discs of material, heated to about 900 °C for about 17.5 hours, were fused without the appearance of having melted, and exhibited no cracking or spalling.

Example 36

The disc of material, heated to about 900 °C for about 36 hours, softened but did not melt to the degree observed for Example 29.

Example 37

The disc of material, heated to about 900 °C, was fused without the appearance of having melted, and exhibited no cracking or spalling.

Examples 40-44

These formulations were reinforced using aluminoborosilicate ceramic fiber yarn ("NEXTEL 312 CERAMIC FIBER"), as shown in FIG. 5. Each sample was heated for about 2 hours at about 950 °C. Example 40 was firm at 950 °C. Example 41 cracked severely and did not hold together very well. Example 42 was soft at 900 °C. Examples 43 and 44 were firm at 900 °C.

Erosion Test

The erosion test was designed to evaluate the ability of an intumescent mounting mat to resist edge erosion from hot, impinging air stream.

A sample of intumescent mat to be tested was cut into a 4.6 cm x 4.9 cm rectangular shape and mounted so that an edge of the cut mat was flush with the leading edges of two independently electrically heated plates. The mat was compressed to a mount density of 0.60 g/cm^3. The top plate was heated to 800 °C and the bottom plate was heated to 475 °C. Air heated to about 615 °C was pulsed over the exposed mat edge at 60 times per minute through the circular 0.32 cm diameter round orifice of a nozzle positioned 1.588 cm (0.625 inch) from the edge of the mat. The gage pressure at the nozzle was about 0.19 MPa (27 psi). The test was terminated after 24 hours or when an erosion depth of 1.27 cm (0.5 inch) was reached.

The amount of erosion was determined by comparing the weight of a mounting mat before and after the test. The erosion rate was determined by dividing the weight lost during a test by the time of the test.

The mounting mat for Example 43 was prepared by pressing the Example 43 edge protectant material edgewise against an edge of an intumescent mat having a weight per unit area value of 3100 g/m^2 (commercially available under the trade designation "INTERAM MAT MOUNT, SERIES IV" from the 3M Company). Prior to the test, the mat was heated to about 800 °C on the top side and 475 °C on the bottom side for about 1 hour to burn the polymeric binder out of the edge protectant material.

The test was repeated for each of Comparative A (tested twice) and Comparative B. Comparative A was an intumescent mounting mat ("INTERAM MAT MOUNT, SERIES IV"). Comparative B was the same as the Comparative A mat except a 40 mesh stainless steel screen (square weave, 0.010 inch diameter wire, 316 stainless steel from Tetko Co. of Briarcliff Manor, NY) was crimped over an edge of the mat, as described in U.S. Pat. No. 5,008,086 (Merry).

The results are shown in Table 2, below.

Example 11

This formulation was formed into a strip and adhered to the edge of the intumescent mat and then covered with a ceramic paper 2.5 cm wide (commercially available from Carborundum Co. of Niagara Falls, NY, under the trade designation "FIBERFRAX" as shown in FIG. 3). The edge protectant material was sufficiently sticky and moldable so that it could be pressed next to the paper and next to the mat without additional adhesive. The Hot Shake test was performed. This sample exhibited very little cracking, good flexibility, and good performance in the test.

Example 12

This formulation was reinforced with fiberglass cloth (commercially available under the trade designation "S-2 GLASS" from Owens Corning Fiberglas Corp. of Granville, OH), as shown in FIG. 3. The mat was prepared as described in Example 11, except the ceramic paper was replaced with the fiberglass cloth. The Hot Shake test was performed. The fiberglass cloth appeared to act as reinforcement and minimized cracking.

Example 13

This formulation was reinforced with an aluminoborosilicate ceramic cloth (commercially available under the trade designation "NEXTEL 312 CERAMIC CLOTH" from the 3M Company). More specifically, the mat was prepared as described in Example 11 except the ceramic paper was replaced by the aluminoborosilicate ceramic cloth. The aluminoborosilicate ceramic cloth was affixed to the edge of a mat by a pressure sensitive adhesive backed film (3M Brand #375 Pressure Sensitive Adhesive Tape). The mat was tested using the Hot Shake test. The ceramic cloth was believed to act as a reinforcement of the edge protectant material.

Cracks were present in the edge protectant material after the Hot Shake test, but the edge protectant material did not separate from the edge of the mat. The cracks appeared to heal by fusion of the edge protectant material. The Example 13 formulation conformed well to the mat edge during the Hot Shake test.

Examples 14-25

These formulations were subjected to 10 thermal cycles in the Hot Shake test. For Examples 14-17, there was an undesirable amount of shrinkage and cracking of the edge protectant material and less than desired adherence to the intumescent mat and underlying ceramic monolith. Although the formulations of Examples 14-17 are considered to be useful as an edge protectant, such formulations are not preferred.

For Examples 15, 16, and 18-25, there was some cracking of the edge protectant material and adherence to the monolith.

Example 38

Example 38 was tested in the same manner as described for Example 1. There was some cracking of the edge protectant material. Further, when the converter was disassembled, the edge protectant material was observed to be loose (i.e., not attached to the edge of the mat).

Example 39

Example 39 was tested in the same manner as described for Example 1. It appeared to conform very well to the mat edge during the tests and had a very good appearance with little or no cracking.

Various modifications and alterations of this invention will become apparent to those skilled in the art without departing from the scope and spirit of this invention, and it should be understood that this invention is not to be unduly limited to the illustrative embodiments set forth herein.

Claims

1. A catalytic converter or a diesel particulate filter comprising:
   (A)
   (a) a metallic casing;

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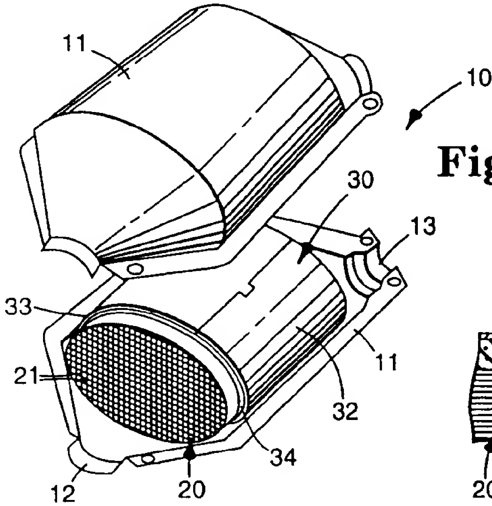

Fig. 1

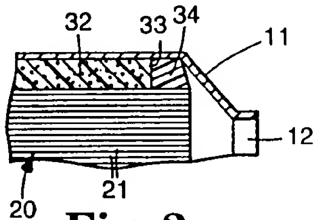

Fig. 2

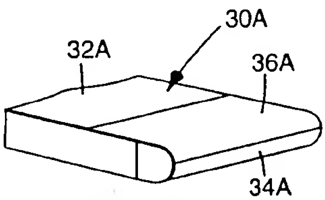

Fig. 3

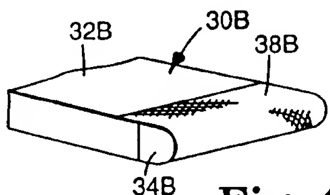

Fig. 4

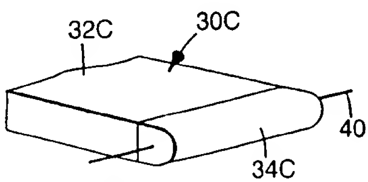

Fig. 5

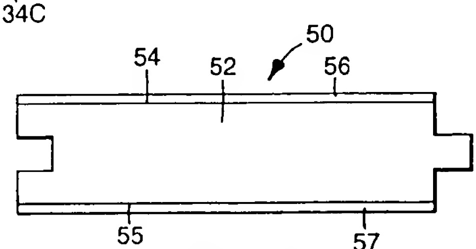

Fig. 6

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 94 11 2862

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A,D	US-A-5 008 086 (MERRY) * the whole document * ---	1,5-7	F01N3/28 F01N3/02
A	DE-A-38 20 981 (LEISTRITZ AG) * column 3, line 33 - column 4, line 36; figures 1,7 * ---	1,3	
A	US-A-4 899 540 (WAGNER) * column 8, line 33 - column 9, line 48; figures 5,7,8 * ---	1	
A,P	GB-A-2 268 695 (A C ROCHESTER AUSTRALIA LIMITED) * page 7, line 26 - page 8, line 30; figures 1,2 * ---	1	
A	DE-C-35 14 150 (LEISTRITZ MASCHINENFABRIK) -----		

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

F01N

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	24 November 1994	Friden, C

CATEGORY OF CITED DOCUMENTS

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